NASA SBIR/STTR Technologies

A3.01-9708 - Nonlinear Parameter-Varying AeroServoElastic Reduced Order Model for Aerostructural Sensing and Control

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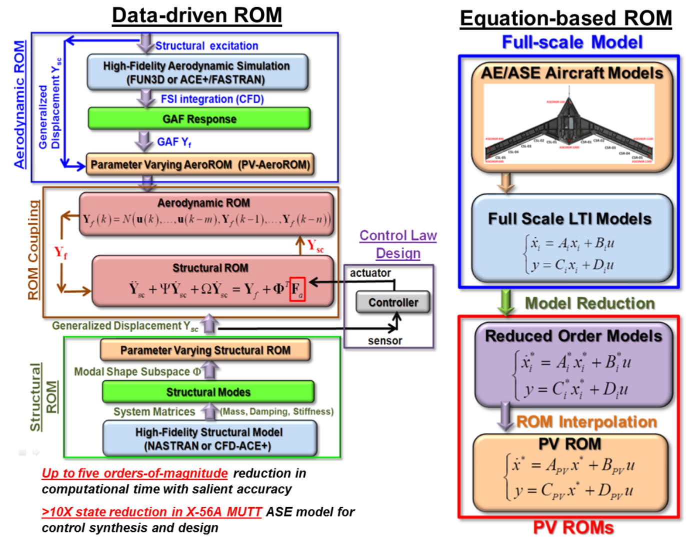
Identification and Significance of Innovation

Aerostructural control methodologies are broadly utilized to suppress instabilities caused by LCO, buffet, gust load, etc. The capability to accurately analyze aeroelasticity (AE) in conjunction with control law design is essential for developing high-performance, safe, aerospace vehicles. The existing AE analysis techniques are ill-suited for aeroservoelasticity (ASE) due to several limitations, including large model dimension and prohibitive computational cost. We propose to develop rigorous reduced order model (ROM) algorithms and software to automatically generate parameter-varying ASE ROM. Key innovations include (1) both data-driven and equation-based ROM techniques to meet various ASE needs in NASA, (2) incorporation of sensors and active structural control into ROMs for integrated simulation; (3) parameter varying techniques to render ASE ROM applicable in broader flight regimes; and (4) modular software to integrate the entire process of PV ASE ROM generation and computation.

Estimated TRL at beginning and end of contract: (Begin: 3 End: 5)



Technical Objectives and Work Plan

The overall project objective is to develop rigorous ROM algorithms and software to automatically generate fully coupled parameter-varying (PV) ASE ROM for active aerostructure and flight control. Phase 2 effort will build on the successful Phase 1 accomplishments and expand the scope of the ASE ROM software development. Specific Phase 2 work areas are: (1) optimizing ROM algorithms and engines in terms of efficiency for MIMO systems, consistent state representation, PV capabilities in a broad flight envelop; (2) developing PV structural ROM to consider changes in modal parameters at various flight conditions for structural dynamics modeling and tuning applications; (3) tailoring strategies of integrating ROMs, sensors and actuators with control design for ASE studies to meet various needs in NASA; (4) developing modular software environment to integrate our ROMs and NASA-relevant tools to facilitate technology insertion and transition; and (5) validating and demonstrating ROM software for ASE and flight control analysis of X-56A MUTT models in the current mission, its future release, and other relevant aircrafts.

NASA Applications

The proposed technology will provide a fast, accurate aeroservoelastic analysis tool with broad NASA applications, including: (1) performing computationally efficient analysis for optimal design of aerospace vehicles; (2) developing advanced, reliable aeroservoelastic control strategies (such as controlled maneuver and aeroelastic instability control, e.g., buffet, flutter, buzz, and control reversal); and (3) arranging test procedures for rational use of instruments and facilities.

Non-NASA Applications

The non-NASA applications focus on aerospace, aircraft, and watercraft engineering sectors involving fluid-structure-control interaction, including US Air Force, Missile Defense, Navy, business aircraft, automobile, and power industry etc. It can be used to (1) perform fault diagnostics and optimized design and (2) develop strategies for on-line process control.

Firm Contacts

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